STATE OF MAINE

DEPARTMENT OF TRANSPORTATION

TRANSPORTATION RESEARCH DIVISION
BUREAU OF PLANNING, RESEARCH & COMMUNITY SERVICES

September 2000

EXPERIMENTAL CONSTRUCTION 92-34

FIELD TRIAL OF GRAVEL STABILIZATION METHODS ROUTE 1, CYR-VAN BUREN, MAINE

6TH INTERIM REPORT

INTRODUCTION

This experimental construction project was developed, designed, and inspected by personnel from the University of Maine, Civil Engineering Staff The experimental project was constructed on and as a part of Project #2586 00 This was a complete reconstruction project 3 54 km (2 2 mi) in length The experimental section contains 6 experimental base types and is 310 m (1020 ft) in length The experimental section began at Station 1028+00 and ended at Station 1038+20 The test section consisted of 60 m (200 ft) segments of soil cement, asphalt, calcium chloride, modified, standard and one 6 m (20 ft) untreated section The stabilized and control sections were located as follows

Soil-Cement Stabilized	STA 1028+00 to 1030+00
Modified Subbase Control	STA 1030+00 to 1032+00
Asphalt Stabilized Section	STA 1032+00 to 1034+00
Untreated Section	STA 1034+00 to 1034+20
Calcium Chloride Stab Section	STA 1034+20 to 1036+20
Standard Subbase Control	STA 1036+20 to 1038+20

The Soil Cement Stabilized section is a mixture of Modified Subbase (mentioned later) and 6 percent by weight of Type I Portland Cement

The Modified Subbase Control section is standard subbase aggregate MDOT specification 703 06b Type D with a 5 1 cm (2 in) maximum aggregate size This aggregate was used on all stabilized sections to facilitate blending of each treatment

The Asphalt Stabilized section is a mixture of modified subbase and 4 5 percent of MS-4 Emulsified Asphalt

The Untreated section consists of Modified Subbase

The Calcium Chloride Stabilized section is a mixture of Modified Subbase and 2 8 l/m^2 (0 75 gal/yd^2) of 35 percent liquid calcium chloride solution

The Standard Subbase Control section consists of standard subbase aggregate MDOT specification 703 06b Type D with a 15 2 cm (6 in) maximum aggregate size

Construction on this project started in September 1990 and was completed in the summer of 1991 A background of the stabilization agents, their uses, advantages and disadvantages is explained in the construction report titled "Experimental Construction 92-34" written in December 1991 This report also provided preliminary design results as well as test results obtained during construction In addition to the test results a plan for long term monitoring was also included in Appendix G and reproduced for this report in Table I Some of the features to be monitored are rutting and serviceability, such as roughness and overall performance Strength measurements using pavement deflection was also suggested Most of the evaluations can be performed with the Automatic Road ANalyzer (ARAN) and Falling Weight Deflectometer test vehicles Long term monitoring of the calcium chloride is specifically mentioned For this phase they recommend boring test holes and sampling the base every 5th year to monitor the possibility of leaching calcium chloride

RESULTS

This report covers the period of time from January 1998 thru December 1999 According to the test schedule in Table I, roughness, rut depths, pavement deflections and crack survey data were obtained

ROUGHNESS MEASUREMENTS

The ARAN test vehicle was replaced in 1998 The new ARAN was used to measure roughness, this is an ASTM Class II profiler using lasers to measure the vehicle's height above the road surface and accelerometers to measure vertical forces caused by surface deformities Measurements are recorded every two inches in each wheel path Data was collected on May 17, 2000 and results are presented in Table II using International Roughness Index (IRI) values Roughness values have increased in all sections with the exception of the south bound Soil Cement section which decreased nearly 31% since 1997

In the Northbound lane, the Standard Subbase continues to be the smoothest section followed by Calcium Chloride, Soil Cement, Modified Subbase and Asphalt Stabilized Base sections

In the Southbound lane, the Soil Cement section is the smoothest followed by Asphalt Stabilized, Standard Subbase, Modified Subbase and Calcium Chloride sections

Overall the Standard Subbase section continues to be the smoothest with an IRI of 76 43 in/mi but this years data increased nearly 67% from 1997 Second smoothest with an IRI of 78 54 in/mi and the smallest increase of 14 54 % is the Soil Cement section followed by the Calcium Chloride section with and IRI of 92 93 in/mi an increase of 65 61%, Asphalt Stabilized with and IRI of 94 55 in/mi an increase of 17 24% and the Modified Subbase with an IRI of 101 53 in/mi an increase of 33 01% Even though the IRI has increased for all sections they are still within the smooth rating of 0-3 m/km (0-190 in/mi)

Some roughness data collected between 1991 and 1997 contradicts itself, one sample year high readings the next year lower readings This could be due to the short length of each test section and the capabilities of the ARAN test vehicle at that time Data was collected between 1991 and 1997 using an older version of ARAN that had a Class III type profiler Class III profilers measure the dynamic response of the vehicle as it travels across the roadway using axle/body accelerometers or other measurement devices This type of roughness measurement is not as accurate or repeatable as the current Class II type ARAN test vehicle Future roughness readings should represent a truer longitudinal profile of each section

RUT DEPTH MEASUREMENTS

The ARAN was also used to measure rut depths Ultrasonic sensors are spaced 10 cm (4 in) apart on a 3 7 m (12 ft) wide smartbar (front bumper) These sensors record distance from the smartbar to the pavement surface Gyroscopes are used to record pitch and roll of the vehicle at each station to determine the pavement slope Depths are measured to the nearest 0 25 cm (0 1 in) Average values for inner and outer wheelpaths per lane per test section are presented in Table III Tests have revealed the following

Rut depths have increased in the inner wheelpath and decreased or remained the same in the outer wheelpath

Calcium Chloride stabilized base has consistently had the least amount of rutting among the stabilized base sections

There is very little change in rut depths throughout the project and these changes are normal for a project of this age

STRUCTURAL MEASUREMENTS

In previous years, MDOT used the Road Rater to record structural measurements In 1997 MDOT purchased a Falling Weight Deflectometer (FWD) to replace the Road Rater Measurements from the Road Rater and FWD are reported in Table IV

Road Rater results are displayed as an overlay required This is the depth of overlay necessary to restore each section to a 20 year design life using 61 cm (24 in) of subbase and 15 cm (6 in) of pavement, the lower the number the stronger the section All readings are negative suggesting no overlay is necessary

The FWD calculates an effective existing pavement structural number This number is calculated using measurements from the first sensor and represents the existing structural number for 61 cm (24 in) of subbase and 15 cm (6 in) of pavement combined, the higher the number the stronger the section Similar roads of this design in the state of Maine have a structural number between 5 and 6 Deflections have revealed the following

The Soil Cement section continues to outperform all sections

The Asphalt Stabilized section is also structurally stronger than all sections with the exception of Soil Cement

Calcium Chloride section had stronger readings than previous tests

The Modified Subbase section is structurally weaker than the other sections closely followed by the Standard Subbase section

A Comparison of Population Means using the F and T test comparing 1997 and 1999 structural data within the same section was performed Data revealed that we cannot reject the null hypothesis at the 95 0% confidence level within each section and that Mean 1997 data equals mean 1999 data for each section

Table V contains results of a multiple comparison test to determine which section(s) is significantly different from each other In 1997 the Soil-Cement Section was significantly different than the Modified, Asphalt, Calcium Chloride and Standard sections In 1999 the Soil Cement section was significantly different than the Modified, Calcium Chloride and Standard sections

VISUAL EVALUATION

Visual inspection and a crack survey of the project were conducted on September 14, 1999 The results are as follows

All cracks were sealed with a rubber sealant since the last evaluation

Asphalt flushing has increased in all sections excluding the Calcium Chloride section which has none

The Modified Subbase, Asphalt Stabilized and Calcium Chloride stabilized sections have full length centerline joint separation Soil Cement centerline separation increased from 21 m (70 ft) to 28 m (92 ft) and the Standard Subbase section has remained the same with a total of 52 m (170 ft) of cracking

All sections have shoulder joint separation The Soil Cement, Modified Subbase and Asphalt Stabilized sections have no additional shoulder joint separation and remain at 33 m (110 ft), 55m (182 ft) and 85 m (280 ft) respectively Calcium Chloride stabilized base increased from 46 m (150 ft) to 47 m (153 ft) and the Standard Subbase section increased from 11 m (35 ft) to 58 m (192 ft)

The Modified Subbase and Calcium Chloride sections have one full width transverse crack with no additional cracking since the 1997 evaluation The Soil cement section has two full width cracks, a 1 m (4 ft) crack at centerline and a new 1 m (4 ft) crack at centerline at station 1029+12 The Asphalt Stabilized area has three transverse cracks, one full width, one three quarters across lanes and a new half width crack in the northbound lane The Standard Subbase section has one full width transverse crack and a new three quarter crack at station 1038+12

The Calcium Chloride section has an additional 6 m (20 ft) of longitudinal cracking between wheel paths bringing the total to 49 m (160 ft) and the Soil Cement section has 1 5 m (5 ft) of cracking between wheelpaths No other sections are experiencing cracking of this type

Load associated cracking has not occurred within the experimental project

RECOMMENDATIONS

The Soil Cement and Asphalt Stabilized sections continue to outperform the other sections structurally and are recommended for use as a soil stabilizer

Calcium Chloride has shown as increase in structural numbers but the pavement is still showing signs of deterioration and roughness has increased suggesting instability Perhaps further evaluation will determine if Calcium Chloride can stabilize the soil in this area

A significant decrease in structural number and increase in rutting of the Standard Subbase section suggests the base material may be beginning to degrade

The Modified Subbase section also has low structural numbers and high roughness readings suggesting degradation of the base and is not recommended as an alternative to our standard subbase material

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Distribution B
Other Available Documents

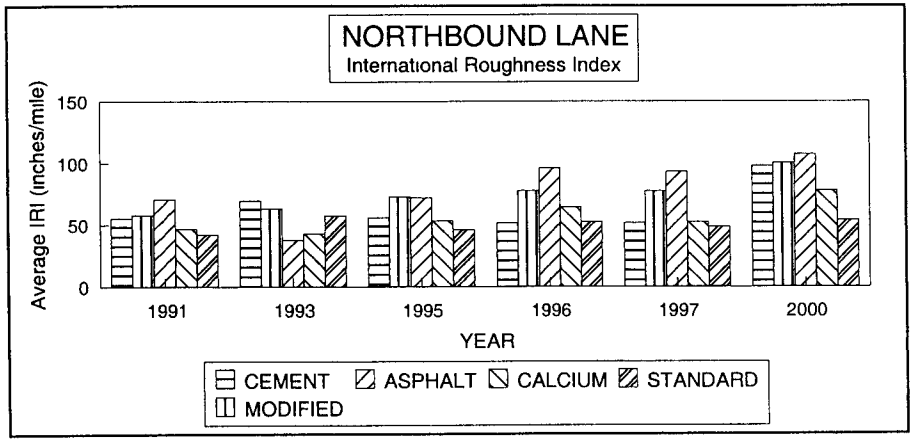
Construction Report December 1991
1st Interim Report May 1993
2nd Interim Report February 1995
3rd Interim Report January 1996
4th Interim Report January 1997
5th Interim Report May 1998

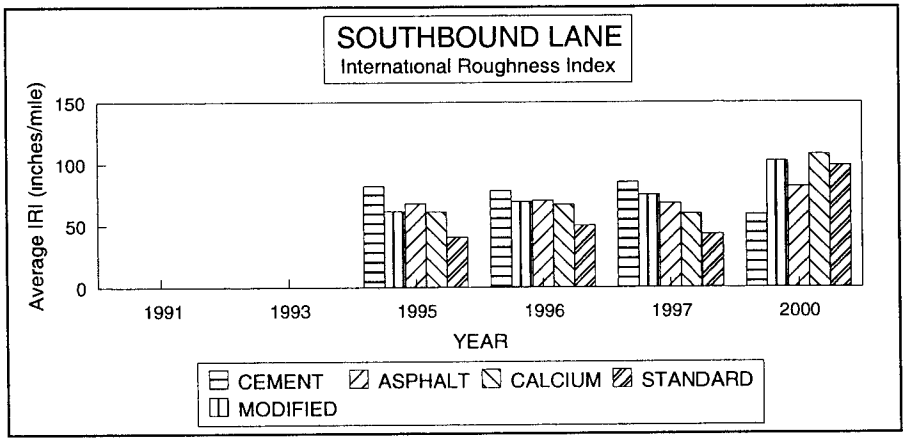
TABLE I
TESTING SCHEDULE FOR CYR - VAN BUREN
FIELD TRIAL OF
GRAVEL STABILIZATION METHODS

YEAR	ARAN Roughness IRI	ARAN Rut	Pavement Deflections	Elev X-sections	Elev Profile	Crack Survey	CaCl2 Leach
1991	*	*	*				
1992	*	*	*	*	*	*	
1993	*	*	*	*	*	*	
1994	*	*	*				
1995	*	*	*	*	*	*	*
1996	*	*	*				
1997	*	*	*	*	*	*	
1998						*	
1999	*	*	*			*	
2000						*	
2001	*	*	*			*	
2002						*	
2003	*	*	*			*	
2004						*	
2005	*	*	*			*	
2006						*	

TABLE II
PHYSICAL PROPERTIES
INTERNATIONAL ROUGHNESS INDEX (Inches / Mile)

	Soil Cement			Modified Subbase			Asphalt Stabilized			Calcium Chloride			Standard Subbase		
Date	NBL Ave	SBL Ave	Section Ave	NBL Ave	SBL Ave	Section Ave	NBL Ave	SBL Ave	Section Ave	NBL Ave	SBL Ave	Section Ave	NBL Ave	SBL Ave	Section Ave
1991	55 67	M	55 67	58 09	M	58 09	70 97	M	70 97	47 09	M	47 09	42 23	M	42 23
1993	69 98	M	69 98	63 40	M	63 4	37 88	M	37 88	43 07	M	43 07	57 66	M	57 66
1995	56 03	82 05	69 04	73 09	61 53	67 31	72 18	68 22	70 20	53 61	61 35	57 48	46 11	40 67	43 39
1996	51 65	78 57	65 11	77 89	69 45	73 67	96 14	70 49	83 32	64 55	67 24	65 90	52 50	50 15	51 33
1997	51 75	85 39	68 57	77 62	75 04	76 33	93 30	67 99	80 65	52 48	59 75	56 12	48 64	42 99	45 82
2000	98 09	58 99	78 54	100 48	102 58	101 53	107 44	81 65	94 55	78 00	107 86	92 93	54 12	98 74	76 43
% Increase	**89 55%**	**-30 92%**	**14 54%**	**29 45%**	**36 70%**	**33 01%**	**15 16%**	**20 09%**	**17 24%**	**48 63%**	**80 52%**	**65 61%**	**11 27%**	**129 68%**	**66 82%**





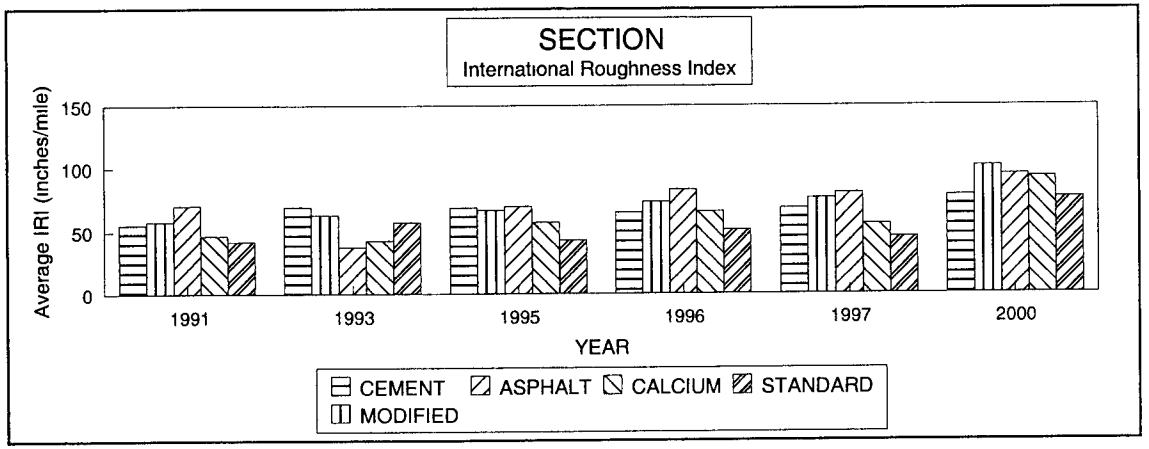


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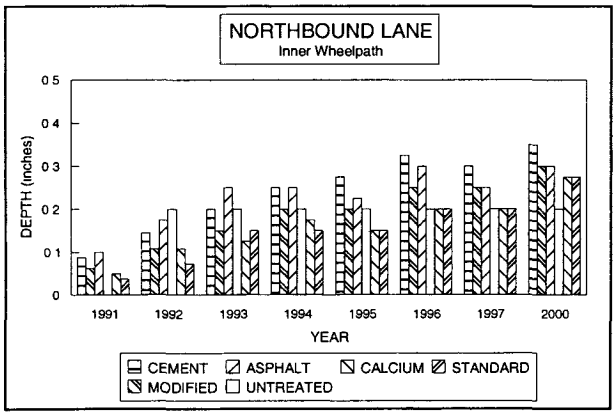
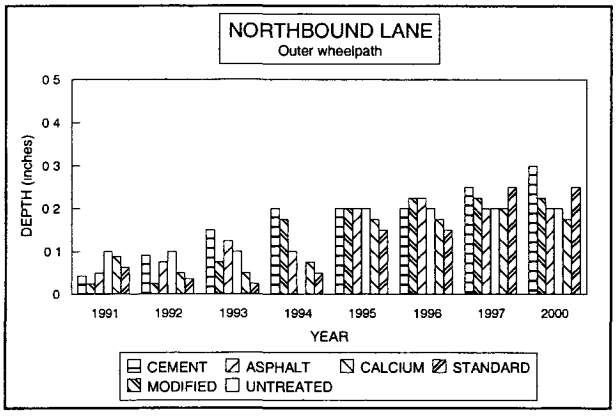
TABLE III
PHYSICAL PROPERTIES
AVERAGE RUT DEPTHS (inches)

NORTHBOUND LANE

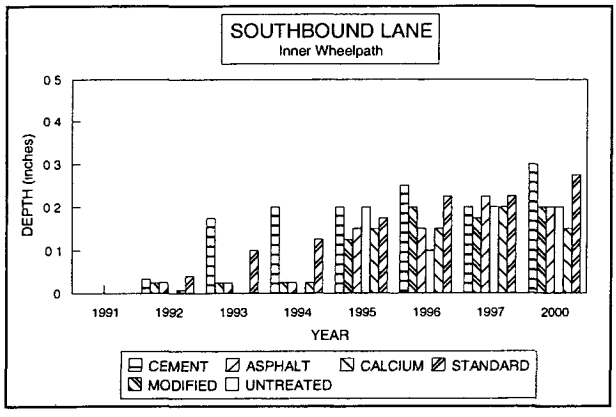
	Inner Wheelpath						Outer wheelpath					
DATE	SOIL CEMENT	MODIFIED SUBBASE	ASPHALT SUBBASE	UN TREATED	CALCIUM CHLORIDE	STANDARD SUBBASE	SOIL CEMENT	MODIFIED SUBBASE	ASPHALT SUBBASE	UN TREATED	CALCIUM CHLORIDE	STANDARD SUBBASE
1991	0 088	0 063	0 100	0 000	0 050	0 038	0 043	0 025	0 050	0 100	0 088	0 063
1992	0 145	0 108	0 175	0 200	0 108	0 073	0 091	0 025	0 075	0 100	0 050	0 036
1993	0 200	0 150	0 250	0 200	0 125	0 150	0 150	0 075	0 125	0 100	0 050	0 025
1994	0 250	0 200	0 250	0 200	0 175	0 150	0 200	0 175	0 100	0 000	0 075	0 050
1995	0 275	0 200	0 225	0 200	0 150	0 150	0 200	0 200	0 200	0 200	0 175	0 150
1996	0 325	0 250	0 300	0 200	0 200	0 200	0 200	0 225	0 225	0 200	0 175	0 150
1997	0 300	0 250	0 250	0 200	0 200	0 200	0 250	0 225	0 200	0 200	0 200	0 250
2000	0 350	0 300	0 300	0 200	0 275	0 275	0 300	0 225	0 200	0 200	0 175	0 250

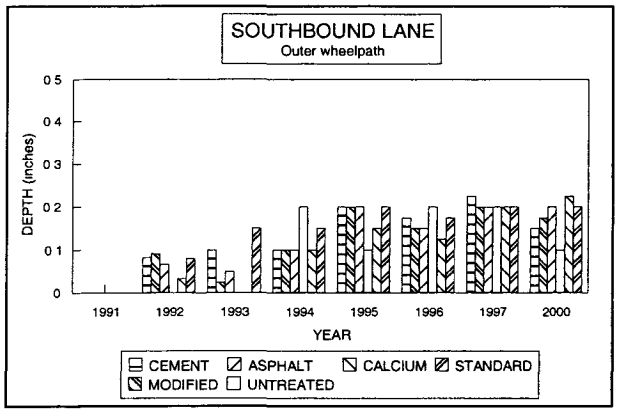




SOUTHBOUND LANE

	Inner Wheelpath						Outer wheelpath					
DATE	SOIL CEMENT	MODIFIED SUBBASE	ASPHALT SUBBASE	UN TREATED	CALCIUM CHLORIDE	STANDARD SUBBASE	SOIL CEMENT	MODIFIED SUBBASE	ASPHALT SUBBASE	UN TREATED	CALCIUM CHLORIDE	STANDARD SUBBASE
1991	M	M	M	M	M	M	M	M	M	M	M	M
1992	0 033	0 025	0 025	0 000	0 008	0 040	0 083	0 092	0 067	0 000	0 033	0 080
1993	0 175	0 025	0 025	0 000	0 000	0 100	0 100	0 025	0 050	0 000	0 000	0 150
1994	0 200	0 025	0 025	0 000	0 025	0 125	0 100	0 100	0 100	0 200	0 100	0 150
1995	0 200	0 125	0 150	0 200	0 150	0 175	0 200	0 200	0 200	0 100	0 150	0 200
1996	0 250	0 200	0 150	0 100	0 150	0 225	0 175	0 150	0 150	0 200	0 125	0 175
1997	0 200	0 175	0 225	0 200	0 200	0 225	0 225	0 200	0 200	0 200	0 200	0 200
2000	0 300	0 200	0 200	0 200	0 150	0 275	0 150	0 175	0 200	0 100	0 225	0 200





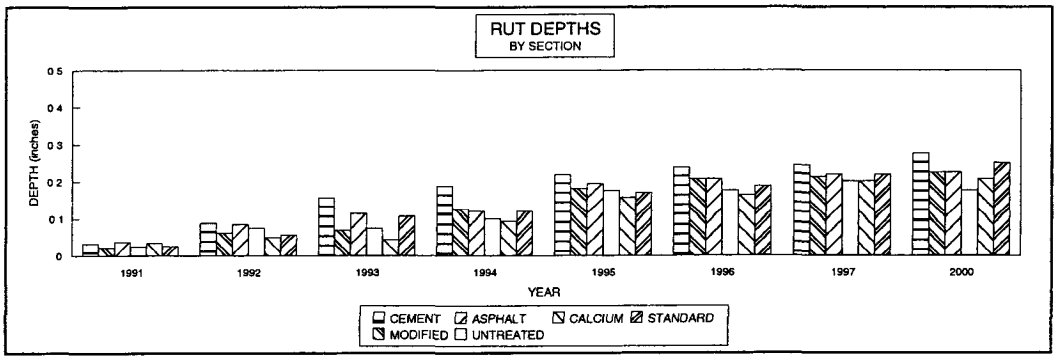


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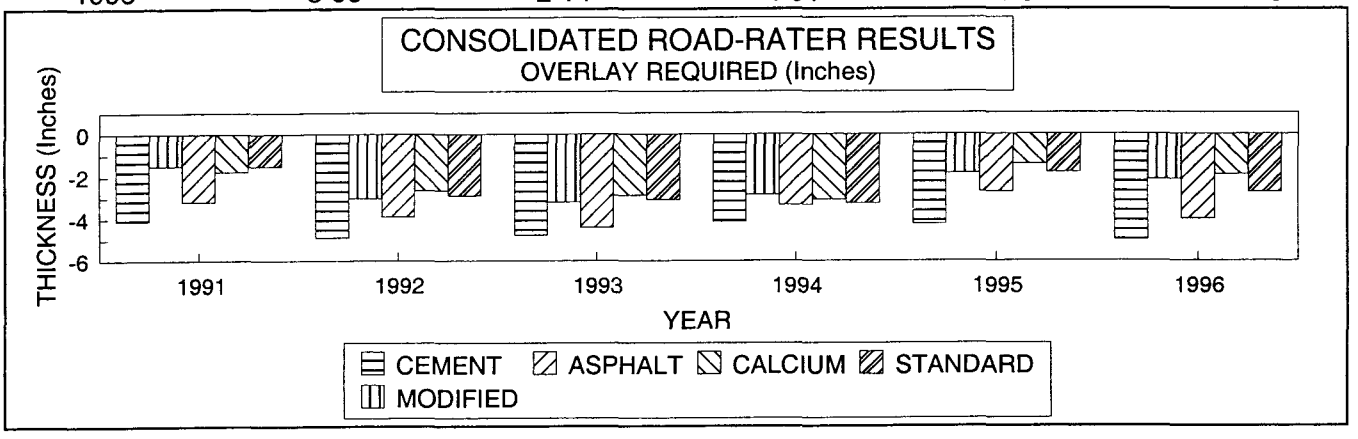
TABLE IV
PHYSICAL PROPERTIES
STRUCTURAL EVALUATION

CONSOLIDATED ROAD-RATER RESULTS

OVERLAY REQUIRED (Inches)

YEAR	SOIL CEMENT	MODIFIED SUBBASE	ASPHALT STABILIZED	CALCIUM CHLORIDE	STANDARD SUBBASE
1991	-4 11	-1 50	-3 19	-1 78	-1 52
1992	-4 90	-3 03	-3 90	-2 66	-2 91
1993	-4 78	-3 21	-4 41	-2 89	-3 08
1994	-4 14	-2 85	-3 35	-3 08	-3 27
1995	-4 24	-1 85	-2 72	-1 42	-1 80
1996	-5 00	-2 14	-4 01	-1 92	-2 75



CONSOLIDATED FALLING WEIGHT DEFLECTOMETER RESULTS

EFFECTIVE EXISTING PAVEMENT STRUCTURAL NUMBER

YEAR	SOIL CEMENT	MODIFIED SUBBASE	ASPHALT STABILIZED	CALCIUM CHLORIDE	STANDARD SUBBASE
1997	7 32	6 41	6 78	6 46	6 55
1999	7 3	6 39	6 84	6 51	6 45

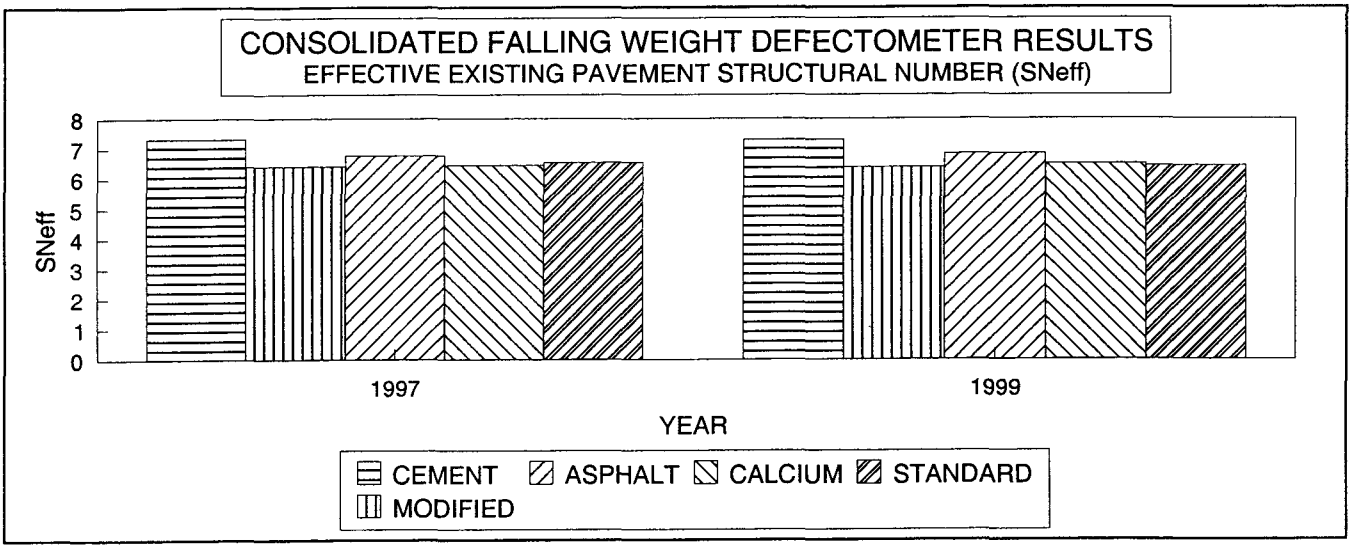


TABLE V
STATISTICAL ANALYSIS of STRUCTURAL MEASUREMENTS

Mutiple Range Tests - 1997 Data
Response variable Deflection
Method 95 0 percent Tukey HSD

Treatment	Count	Mean	Homogeneous Groups
Modified	4	6 4125	X
Standard	4	6 4625	X
CaCL2	4	6 5375	X
Asphalt	4	6 7825	X
Soil-Cement	4	7 32	X

Contrast	Difference	+/- Limits
Cement - Modified	*0 9075	0 453788
Cement - Asphalt	*0 5375	0 453788
Cement - CaCL2	*0 8575	0 453788
Cement - Standard	*0 7825	0 453788
Modified - Asphalt	-0 37	0 453788
Modified - CaCL2	-0 05	0 453788
Modified - Standard	-0 125	0 453788
Asphalt - CaCL2	0 32	0 453788
Asphalt - Standard	0 245	0 453788
CaCL2 - Standard	-0 075	0 453788

Mutiple Range Tests - 1999 Data
Response variable Deflection
Method 95 0 percent Tukey HSD

Treatment	Count	Mean	Homogeneous Groups
Modified	4	6 3925	X
Standard	4	6 4525	X
CaCL2	4	6 505	X
Asphalt	4	6 8375	X X
Soil-Cement	4	7 3025	X

Contrast	Difference	+/- Limits
Cement - Modified	*0 91	0 498976
Cement - Asphalt	0 465	0 498976
Cement - CaCL2	*0 7975	0 498976
Cement - Standard	*0 85	0 498976
Modified - Asphalt	-0 445	0 498976
Modified - CaCL2	-0 1125	0 498976
Modified - Standard	-0 06	0 498976
Asphalt - CaCL2	0 3325	0 498976
Asphalt - Standard	0 385	0 498976
CaCL2 - Standard	0 0525	0 498976

* Denotes a statistically significant difference